



International Actuarial Association Health Section
2007 Colloquium

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Cost-calibrated risk assessment and machine underwriting

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Risk Assessment in Health Insurance

- 1 General concepts and aims of scoring**
- 2 Medical approach to risk in health insurance**
- 3 Classical evaluation of risk**
- 4 Scoring of medical risks**
- 5 Maschine underwriting based on scoring**

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Scoring renders possible: cost-calibrated risk assessment

- **Structure of the tariffs and loadings exactly compensate any excess risk**
- **Premium and loadings are calibrated according to the individual risk**
- **In life and disability insurance the risk is measured by mortality / disability tables in a normalized form.**

Actuarial tables in Life insurance

Life	Disability	Health
mortality tables	disability tables	morbidity tables (med.-biol. structures)
	reactivation tables	med. econometric tables (cost structures)
		benefit plans (structures of tariffs)
1-dimensional	1-dimensional	multidimensional

Cost-calibrated risk assessment

by evaluation and balancing of

- **Database of medical history (anamnesis)**
- **Database of contract information (personal data)**
- **Database of claims**

Multivariate recognition of patterns of risk constellations

Discriminant analysis / Scoring methods

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Medical and Actuarial Risk Evaluation

Evaluation by med. Doctors

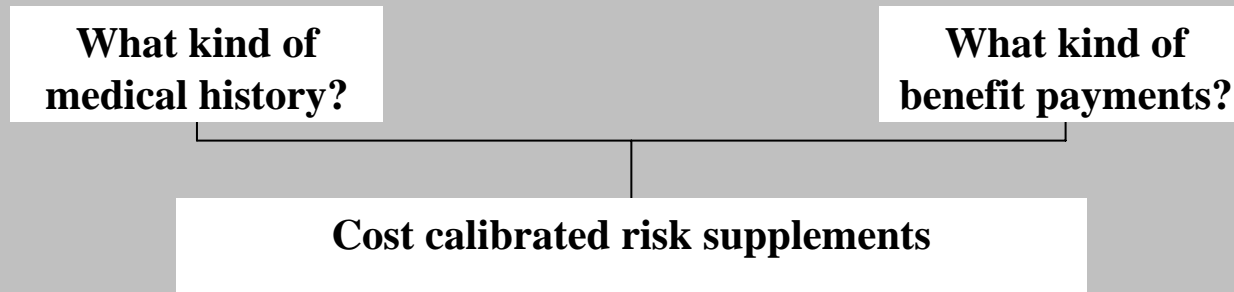
- Assessment of the actual condition
- incomplete, partly detailed med. knowledge
- detailed knowledge of few patients
- Evaluation of the impact of the medical condition affected by subjective criteria
- Representative average over all age groups / all diseases
- Doctors play down wide-spread, but mild cases of previous illnesses
- **Calibration according to subjective suffering**

Evaluation by Actuaries

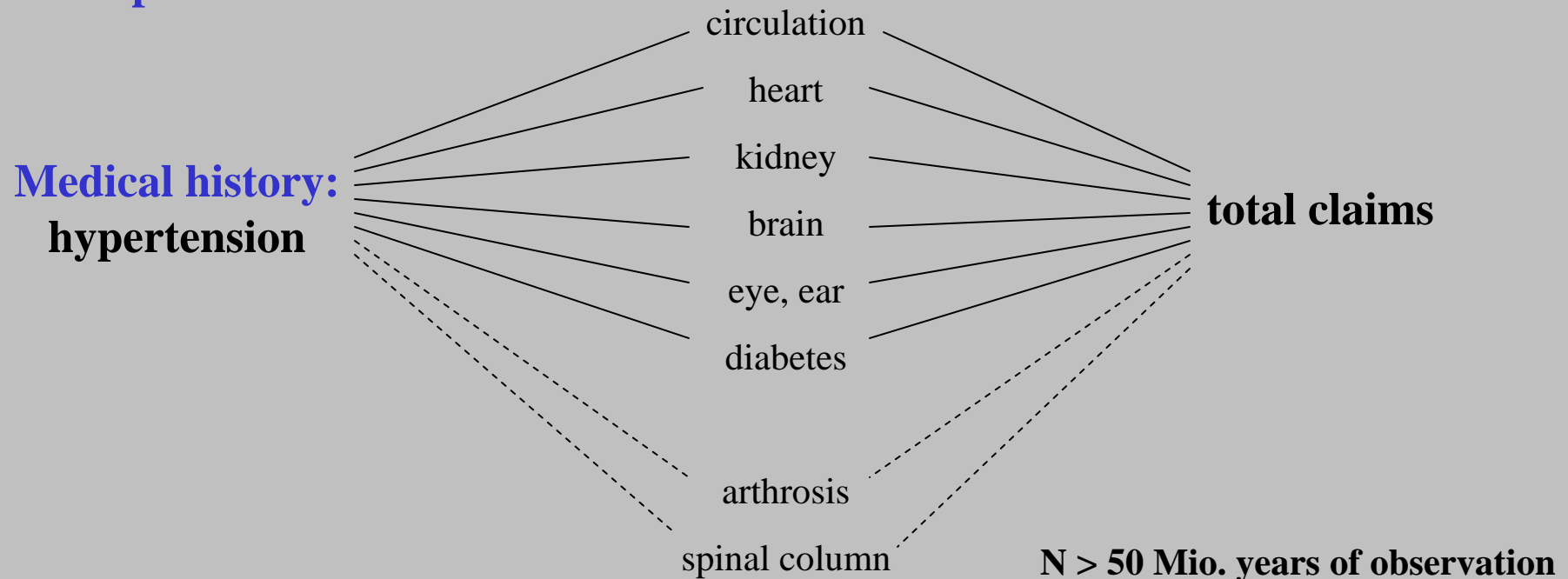
- Long term evaluation (past / future)
- Complete, but superficial med. knowledge
- Essential data of many patients
- Evaluation of the future pressure of costs
- For anamnesis:
Mainly diseases of the age group 30 - 45,
evaluation of all age groups with respect to claims
- High costs from wide-spread, but mild cases of previous illnesses
- **Calibration according to the cost**

Systematics of Risk Evaluation

- **Retrospective view:**



- **Example:**



Main benefit payments

(Men, outpatient treatment)

No.	Age 20 - 29	Age 30 - 34	Age 35 - 39	Age 40 - 44	Age 45 - 49	Age 50 - 54	Age 55 upwards
1.	spinal column / skeleton 19%	spinal column / skeleton 21%	spinal column / skeleton 22%	spinal column / skeleton 23%	spinal column / skeleton 23%	spinal column / skeleton 23%	spinal column / skeleton 22%
2.	Spectacles 13%	Spectacles 14%	Spectacles 11%	Spectacles 11%	Spectacles 16%	Spectacles 15%	heart / blood circulation 18%
3.	Fractures / Luxations 13%	Respiratory tract 10%	Respiratory tract 9%	heart / blood circulation 9%	heart / blood circulation 10%	heart / blood circulation 14%	Spectacles 12%
4.	Respiratory tract 11%	Fractures / Luxations 7%	heart / blood circulation 6%	Respiratory tract 8%	Respiratory tract 6%	Respiratory tract 6%	Respiratory tract 5%
5.	Dermatological disorders 5%	heart / blood circulation 5%	Fractures / Luxations 6%	Digestive tract 5%	Digestive tract 5%	Digestive tract 5%	Cancer 5%
6.	heart / blood circulation 4%	Digestive tract 4%	Digestive tract 5%	Infections 5%	Infections 5%	Cancer 3%	Digestive tract 5%
7.	Digestive tract 4%	Mental disorders 4%	Mental disorders 5%	Mental disorders 5%	Fractures / Luxations 3%	Metabolic disorders 3%	Metabolic disorders 3%

Main benefit payments

(Men, inpatient treatment)

No.	Age 20 - 29	Age 30 - 34	Age 35 - 39	Age 40 - 44	Age 45 - 49	Age 50 - 54	Age 55 upwards
1.	Fractures / Injuries 26%	Fractures / Injuries 27%	Fractures / Injuries 15%	heart / blood circulation 21%	heart / blood circulation 23%	heart / blood circulation 30%	heart / blood circulation 35%
2.	Cancer 12%	Digestive tract 13%	Digestive tract 13%	Digestive tract 13%	Digestive tract 13%	Digestive tract 14%	Digestive tract 13%
3.	Digestive tract 11%	Respiratory tract 10%	heart / blood circulation 11%	Fractures / Injuries 13%	spinal column/ skeleton 12%	spinal column/ skeleton 11%	Cancer 12%
4.	spinal column/ skeleton 8%	spinal column/ skeleton 10%	spinal column/ skeleton 10%	spinal column/ skeleton 13%	Fractures / Injuries 10%	Cancer 11%	spinal column/ skeleton 9%
5.	Respiratory tract 8%	heart / blood circulation 7%	Cancer 10%	Respiratory tract 7%	Cancer 10%	Fractures / Injuries 7%	Respiratory tract 4%
6.	Wounds / Trauma 7%	Mental disorders 6%	Mental disorders 8%	Mental disorders 6%	Respiratory tract 5%	Respiratory tract 4%	Fractures / Injuries 3%
7.	Mental disorders 5%	Infections 5%	Respiratory tract 7%	Infections 5%	Mental disorders 5%	Mental disorders 4%	Veneral diseases 3%

Main benefit payments

(Women, outpatient treatment)

No.	Age 20 - 29	Age 30 - 34	Age 35 - 39	Age 40 - 44	Age 45 - 49	Age 50 - 54	Age 55 upwards
1.	Uterus / Ovaries 18%	Uterus / Ovaries 17%	spinal column / skeleton 16%	spinal column / skeleton 20%	spinal column / skeleton 21%	spinal column / skeleton 21%	spinal column / skeleton 23%
2.	Pregnancy 16%	Pregnancy 17%	Uterus / Ovaries 15%	Uterus / Ovaries 12%	Spectacles 13%	Spectacles 13%	heart / blood circulation 14%
3.	spinal column / skeleton 13%	spinal column / skeleton 12%	Pregnancy 10%	Spectacles 10%	Uterus / Ovaries 12%	Uterus / Ovaries 11%	Spectacles 12%
4.	Spectacles 10%	Spectacles 9%	Spectacles 8%	Respiratory tract 7%	heart / blood circulation 7%	heart / blood circulation 8%	Uterus / Ovaries 7%
5.	Respiratory tract 6%	Respiratory tract 6%	Respiratory tract 7%	heart / blood circulation 6%	Respiratory tract 5%	Cancer 8%	Respiratory tract 5%
6.	Dermatological disorders 4%	Mental disorders 5%	Mental disorders 6%	Mental disorders 5%	Cancer 5%	Respiratory tract 5%	Cancer 4%
7.	heart / blood circulation 3%	heart / blood circulation 3%	heart / blood circulation 4%	thyroid / endocr. glands 4%	Mental disorders 4%	Mental disorders 4%	Digestive tract 4%

Main benefit payments

(Women, inpatient treatment)

Lfd. Nr.	Age 20 - 29	Age 30 - 34	Age 35 - 39	Age 40 - 44	Age 45 - 49	Age 50 - 54	Age 55 upwards
1.	Pregnancy 53%	Pregnancy 57%	Pregnancy 33%	Benign neoplasms 14%	Benign neoplasms 17%	Cancer 16%	heart / blood circulation 21%
2.	Uterus / Ovaries 6%	Uterus / Ovaries 9%	Uterus / Ovaries 11%	Uterus / Ovaries 13%	heart / blood circulation 15%	heart / blood circulation 13%	Cancer 17%
3.	Digestive tract 6%	Digestive tract 4%	Benign neoplasms 8%	Cancer 9%	Cancer 14%	Benign neoplasms 11%	spinal column / skeleton 12%
4.	Mental disorders 6%	Fractures / Injuries 4%	Digestive tract 7%	spinal column / skeleton 9%	Digestive tract 10%	Digestive tract 11%	Digestive tract 11%
5.	spinal column / skeleton 5%	spinal column / skeleton 4%	Mental disorders 7%	heart / blood circulation 8%	Uterus / Ovaries 9%	spinal column / skeleton 11%	Fractures / Injuries 7%
6.	Fractures / Injuries 5%	Benign neoplasms 4%	Cancer 6%	Pregnancy 8%	spinal column / skeleton 7%	Uterus / Ovaries 9%	Benign neoplasms 5%
7.	Respiratory tract 4%	Cancer 3%	spinal column / skeleton 5%	Digestive tract 7%	Fractures / Injuries 6%	Fractures / Injuries 7%	Uterus / Ovaries 5%

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Number of anamnesises and risk (Men, outpatient treatment)

Number of anamnesises	Percent of policy holders	benefit payments [EUR / year]	gain index *)	frequency index
0	38,8%	325	71%	89%
1	30,1%	425	96%	99%
2	16,1%	500	115%	107%
3	7,5%	625	140%	116%
4	3,8%	700	159%	124%
5	1,8%	850	191%	130%
6	1,0%	1.000	225%	133%
7	0,5%	1.075	231%	139%
8	0,3%	1.075	231%	140%
9	0,2%	1.225	292%	139%
total	100,0%	450	100%	100%

Additional yearly amount of premium (per 10,000 PH): 0.7 Mio. EUR

Potential reduction of the base premium: 9%

*) gain index = Comparison of claims ratio (in the segment) with total claims ratio = $\frac{\text{Benefits (Seg)} / \text{Premium (Seg)}}{\text{Benefits (total)} / \text{Premium (total)}}$

Risk of special anamnesises

(Men, outpatient treatment)

anamnesis		percent of PH	benefit payments [EUR / year]	gain index	frequency index
disorders of thyroid	no	98,8%	439	99%	100%
	yes	1,2%	794	131%	125%
	total	100,0%	453	100%	100%
mental disorders	no	98,9%	478	99%	100%
	yes	1,1%	880	194%	127%
	total	100,0%	453	100%	100%
hypertension	no	97,9%	442	98%	99%
	yes	2,1%	961	147%	123%
	total	100,0%	453	100%	100%
liver / gall / pancreas	no	98,5%	445	97%	100%
	yes	1,5%	947	227%	123%
	total	100,0%	453	100%	100%
spinal column / skeleton	no	91,1%	424	94%	98%
	yes	8,9%	700	138%	114%
	total	100,0%	453	100%	100%

Benefit payments for policyholders with previous disease:

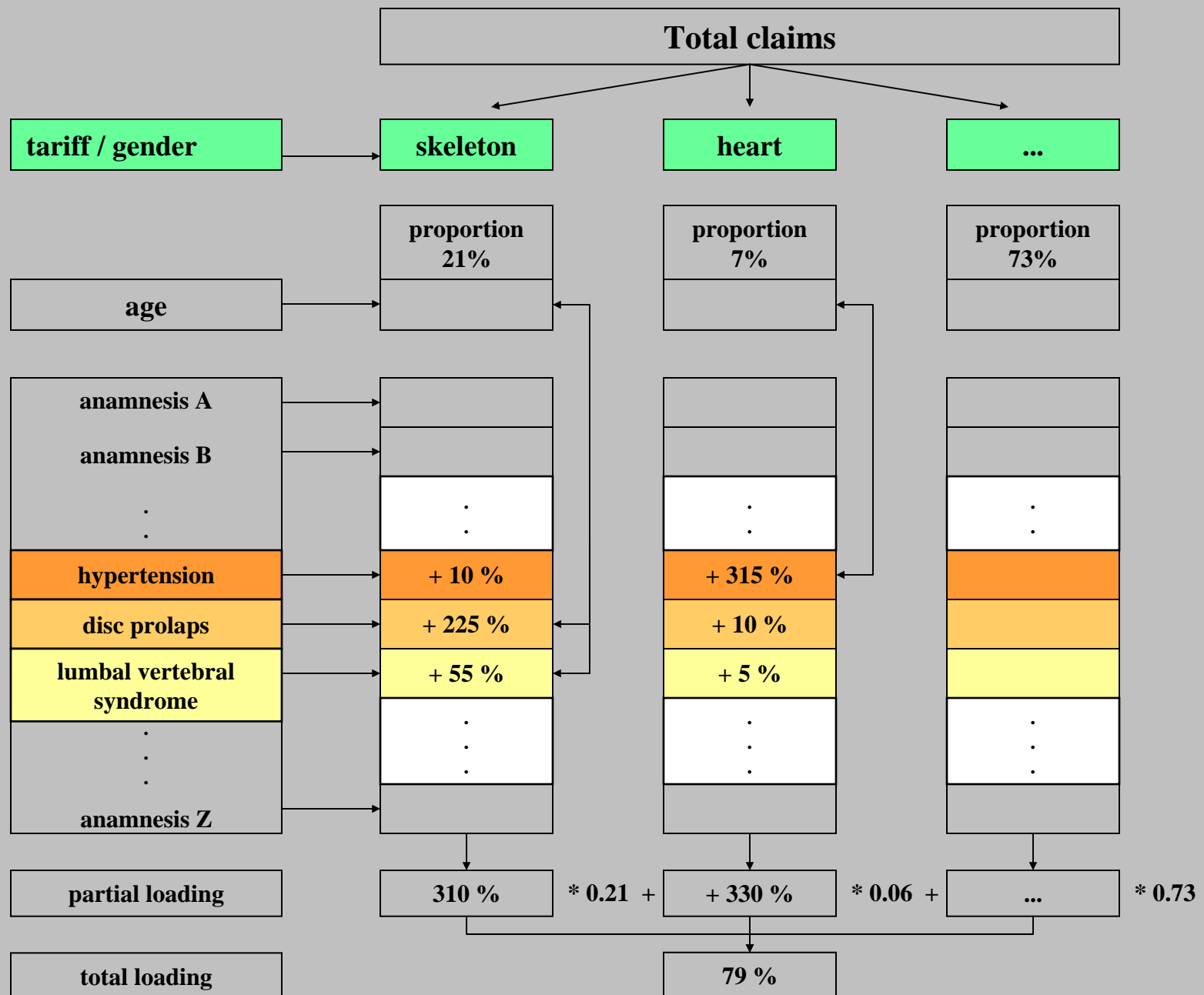
Haemorrhoids (outpatient treatment)

Index year		Following years			
		cases of treatment per PH and year	Rate of illness haemorrhoids per PH and year	benefits total [EURO / year]	benefits haemorrhoids [EURO / year]
Men	no	3.2	2%	425	3
	yes	8.4	51%	1,075	60
Women	no	6.4	2%	800	3
	yes	13.1	25%	1,600	25

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Health insurance as a set of insurances for organ systems

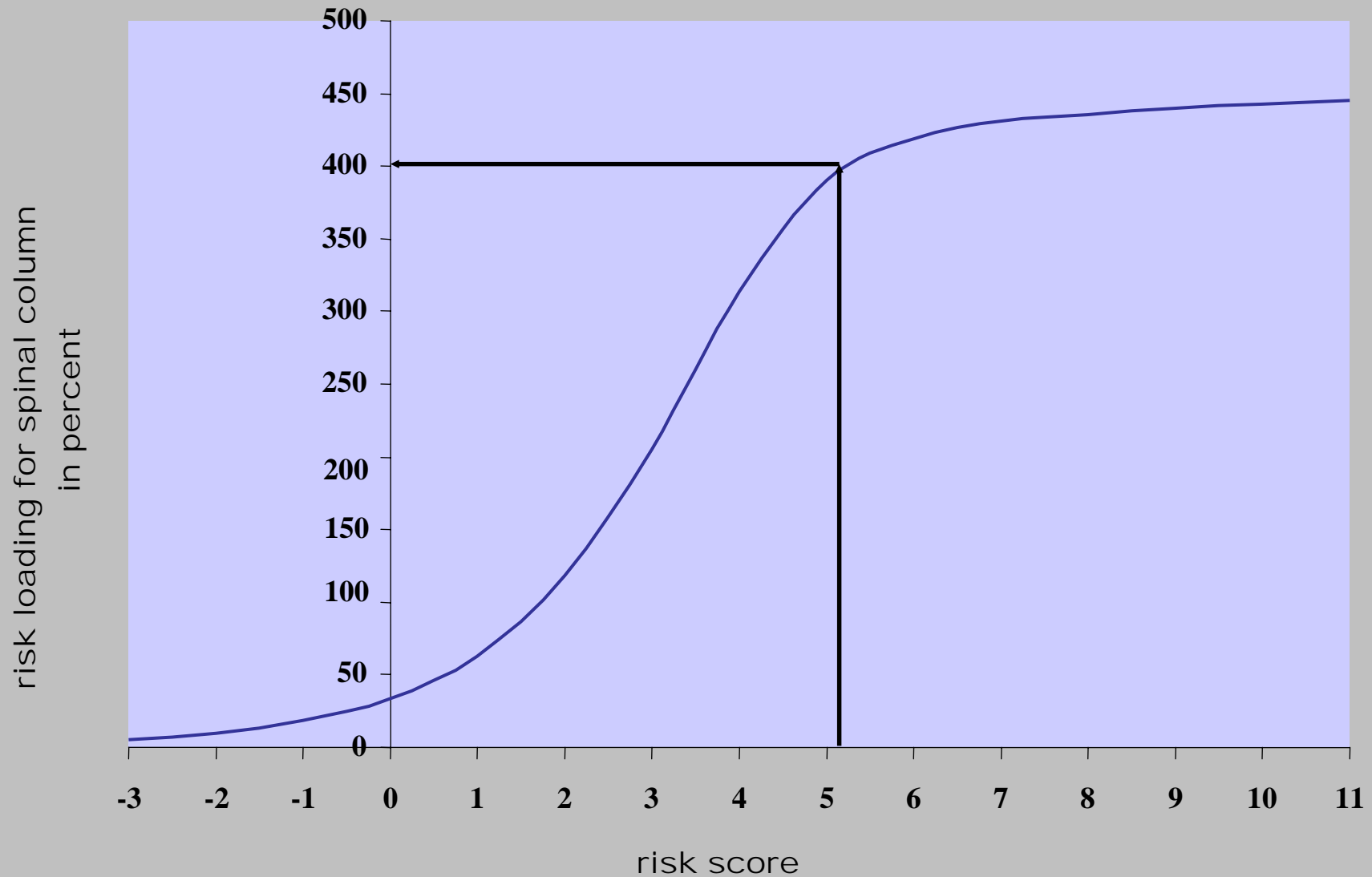


Discriminant analysis: Illness of the spinal column

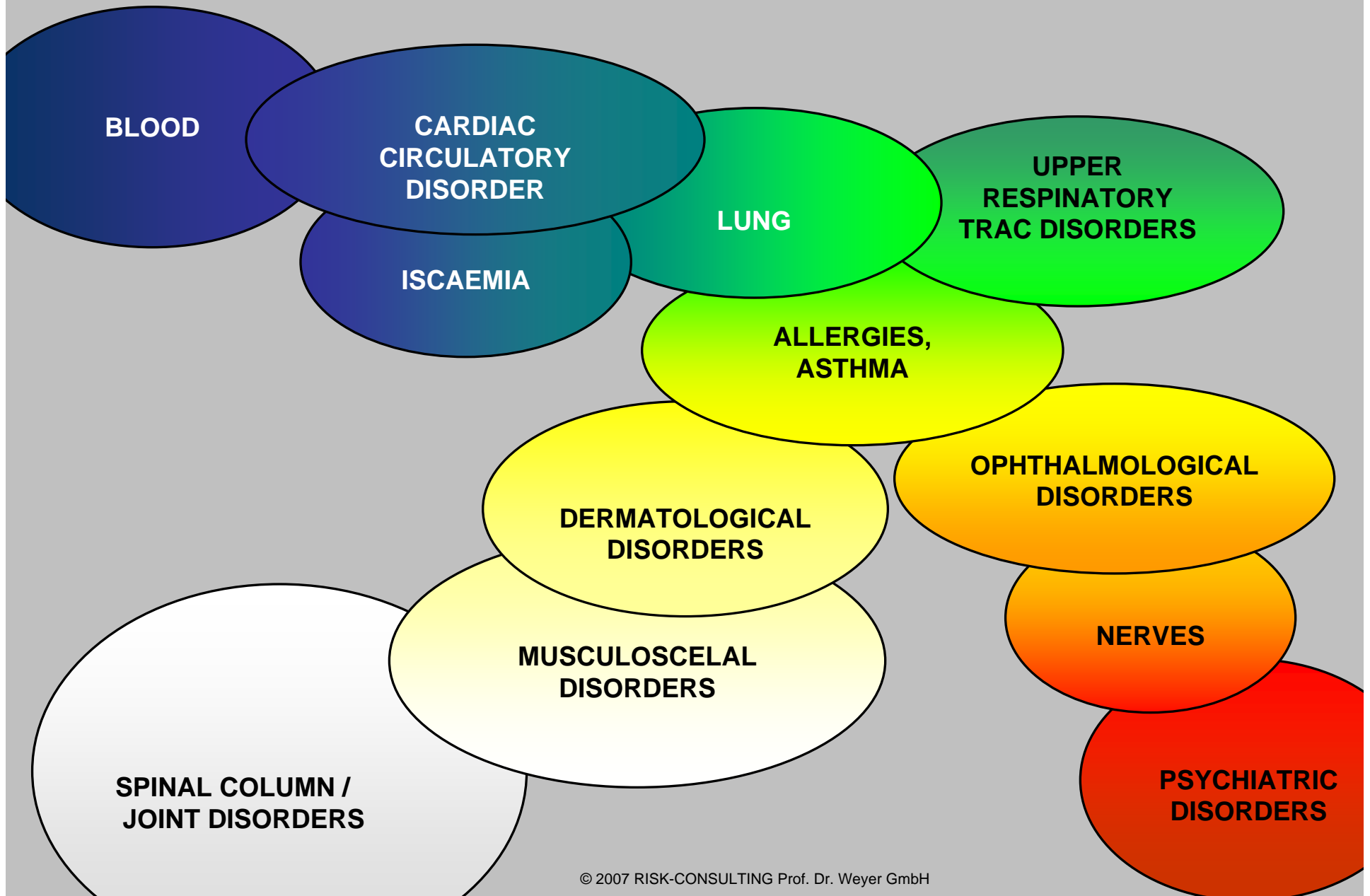
Anamnesis - Men	standardized (relative influence)	unstandardized (absolute influence)
lumbal vertebral syndrome	0.48	0.968
disk prolaps	0.27	2.447
scoliosis	0.25	1.251
spinal fusion	0.02	1.973
coxarthritits	0.12	2.629
3000 other previous illnesses
age	0.29	0.862
constant	-2.633

New customer					Score:
lumbal vertebral syndrome	yes:	1		1	* 0.968
disk prolaps	no:	0	+	0	* 2.447
scoliosis	yes:	2	+	2	* 1.251
spinal fusion	no:	0	+	0	* 1.973
coxarthritits	no:	0	+	0	* 2.629
3000 other previous illnesses	no:	0	+	**	* ***
age	35		+	35	* 0.862
constant					2.633
				sum = total score	= 5.192

Risk loadings depending on the risk score (Spinal column)



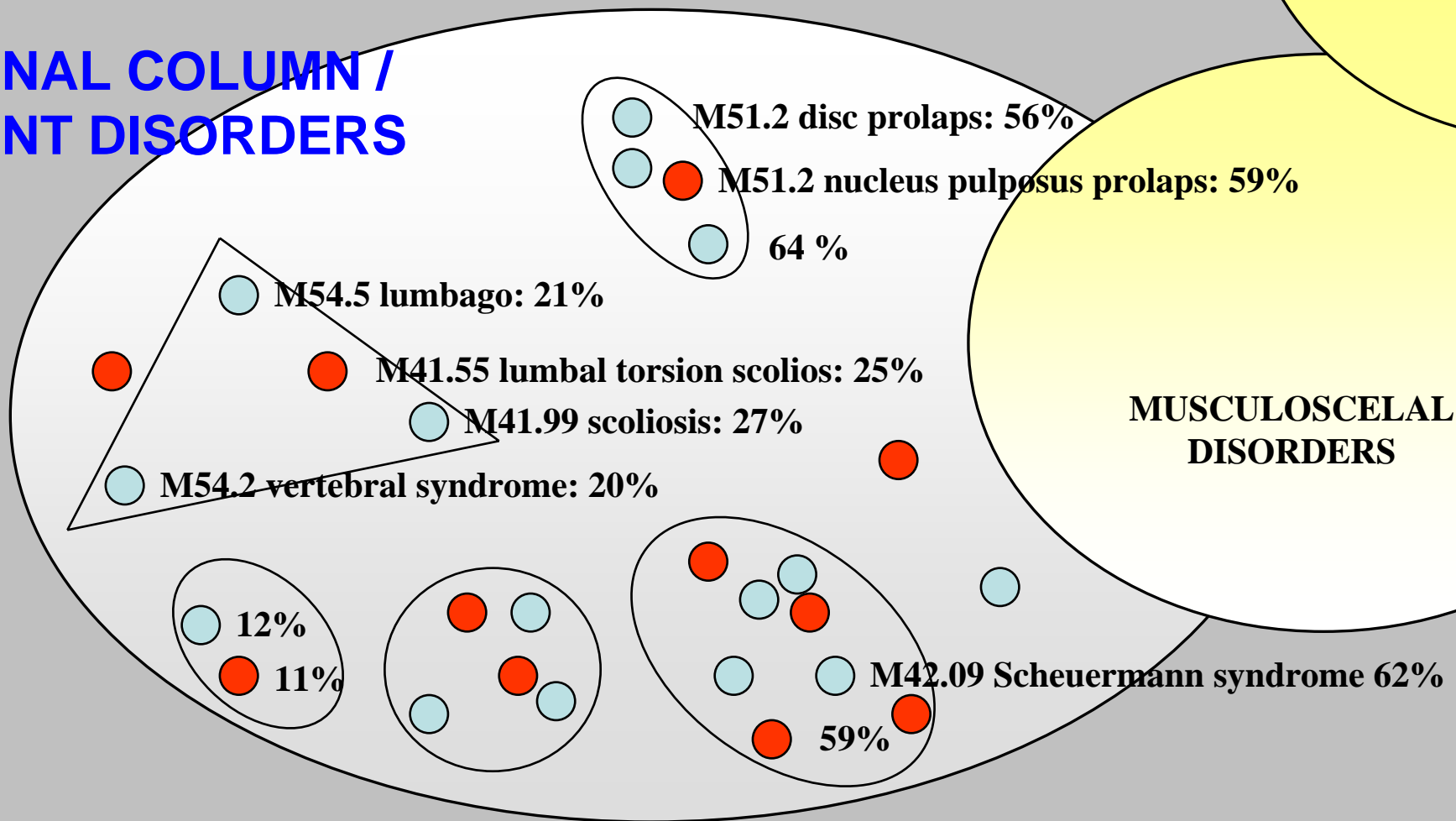
Landscape of Illnesses



Landscape of Illnesses

Network of related diseases

SPINAL COLUMN / JOINT DISORDERS



SIGNIFICANCY

Loss of significance by application of segmentation techniques

- Segments, that are characterized by several characteristics, are sparsely filled:
(Women, age 30-35, weight 50-55 kg, previous illnesses:
hay fever, endometriosis, disc prolaps)
- The cells of the n-dimensional space of characteristics are almost empty

Maintainance of significance by the use of discriminant analysis

- No segments are built
- "Neighboring" information is used
- Scoring provides a projection of the n-dimensional space of characteristics on the one-dimensional scale of scores
- The nonlinear scale of scores is transformed into a linear scale of supplements

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Underwriting system for health insurance

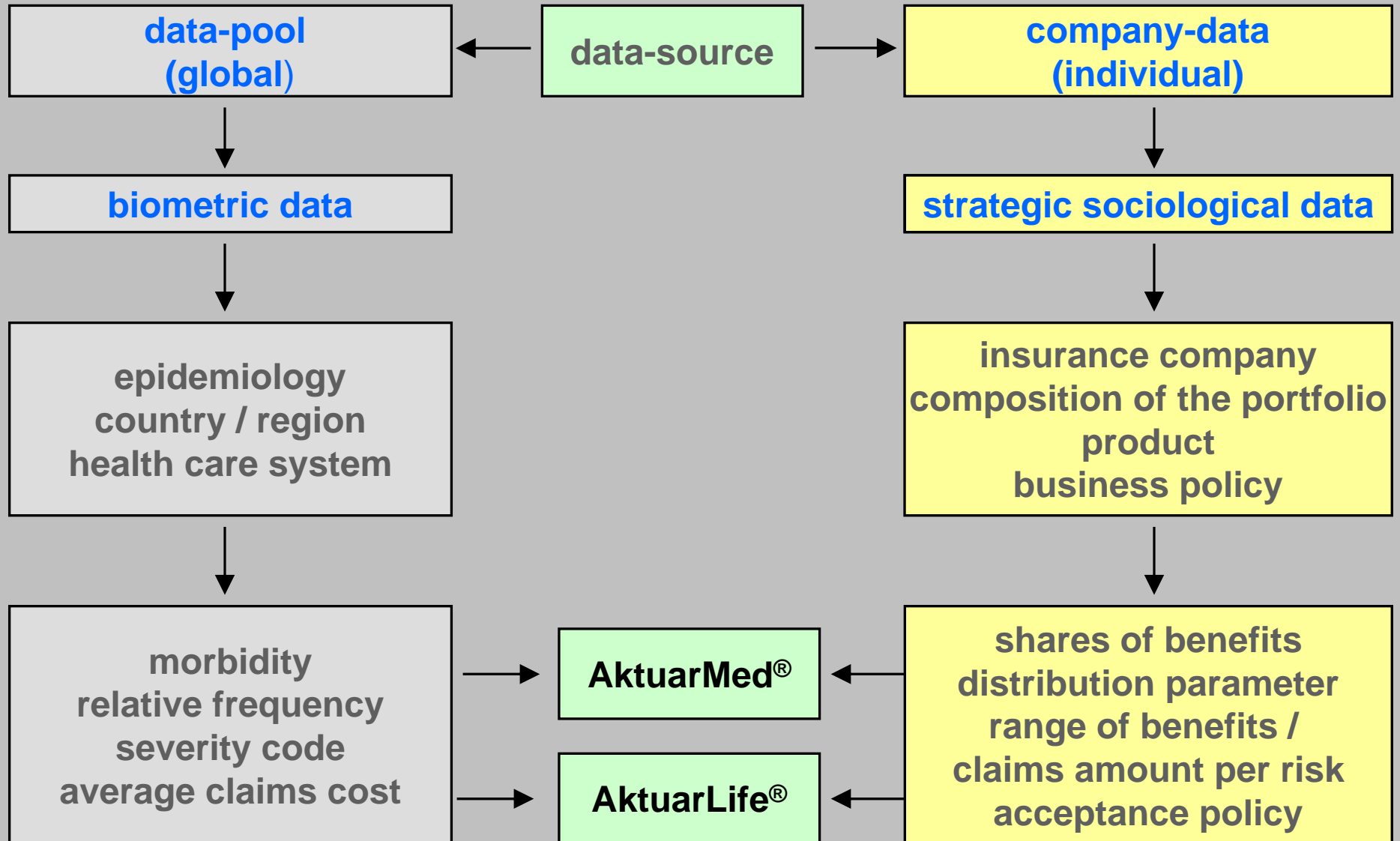
AktuarMed®

- **Actuarial risk-knowledge available by means of a program.**
- **No "empty shell" into which the health insurance fills traditional specialist-knowledge.**

New: Underwriting system for life insurance

AktuarLife®

Company tailored adaptation of AktuarMed® and AktuarLife®



Advantages of any automatic underwriting system

- **Standardized risk policy**
- **Underwriting by less specialized personnel**
- **Reduction of personnel and material costs**
- **Standardization of processes**

Additional advantages of cost-calibrated risk assessment calculation and gains

- **Risk loading in accordance with the real cost expectancy: cost-calibration**
- **No cross-subsidizations, lower premiums for the majority of applicants**
- **Advantages for sales departments: Lower premiums for 85% of the new customers, financial disadvantages only for 15% of the new customers**
- **Transparency in respect of corporate loading strategies**

Additional advantages of cost-calibrated risk assessment

Quick decision-making processes

- **Immediate terminal valuation in 85 - 95 % of the cases**
- **No enquiries to medical doctors in order to determinate the severity level**
- **Enquiries to physicians only if vague medical information is provided by the applicant**
- **Shorter processing times, fewer applications come to nothing**
- **Risk examination and final underwriting at the POS**
- **Product-change module**

"Very good" rating of the underwriting with AktuarMed®

**Quotation: ASSEKURATA-Rating of Gothaer Krankenversicherung
AG (July 2004)**

"The risk loading of the Gothaer Kranken from the point of view of ASSEKURATA rated as very good. Gothaer applies a very high-capacity, computer-assisted expert system, which is able to automatically assess medical terms (diagnosis, synonyms, modes of treatment and abbreviations). Moreover recognizes the system connections of different clinical pictures and accounts for this in the evaluation of the overall risk. With the help of this system the Gothaer Kranken is able to process over 90% of the incoming applications terminally in very short time, without neglecting the corresponding testing-aspects."

Source: www.assekurata.de

Quality of the acceptance policy material to premium stability

Quotation: ASSEKURATA Assekuranz Rating-Agentur GmbH

"Material to the premium-stability is the quality of the acceptance policy, because it is crucial for the future development of the premiums. When a health insurer has taken a bad risk into his portfolio without premiums (risk loadings) suitable to the hazard, he cannot part with the customer again due to the missing right of cancellation.

Assumptions of a certain state of health of the new customers form the basis of the premium calculation. If the new customer have previous illnesses on application, this higher risk has to be financed by individual premium loadings. If this is not realized because of an insufficient examination of the state of health (or ambitious sales objectives), the illness-costs-estimate set for the calculation proves to be too low. In the end the premiums for all insured persons have to be raised to compensate the insufficient risk loadings.

AktuarMed[®] screen-shot

AktuarMed[®] - Interactive Risk Evaluation Private Health Insurance

File ?

Policy Details | **Conditions** | Medical Parameters | Results | Report

Policy Holder

Name: Peter Random

Policy No.: 123456789

Person No.: 01

Gender: male
 female

Current Age: 35 year(s)

Height: 178 cm

Weight: 82 kg

Products

Products

- Compact Comfort
- Ambulant Basic
- Ambulant Deductible
- Hospital Basic
- Hospital Plus
- Dental Basic
- Daily Indemnity 43

Selected Products

Change	Product
<input type="checkbox"/>	Compact Comfort
<input type="checkbox"/>	Ambulant Basic
<input type="checkbox"/>	Hospital Plus
<input type="checkbox"/>	Dental Basic

Discontinued Products

Product	Total LD [...]

Search:

<< Back Next >>

Case Date:--- ED19 3.34.2 534 08.05.2007 18:42

AktuarMed® screen-shot

AktuarMed® - Interactive Risk Evaluation Private Health Insurance

File ?

Policy Details | Conditions | Medical Parameters | Results | Report

ICD	Condition	from	to	Status	BE/BR for discont. Product	BE/BR
I10.90	Hypertension	04.2005	---			

Add Condition

ICD	Condition	Type	Disease Group
E78.0	Hypercholesterolaemia		Metabolic / Blood System Di...
E78.0	Familial hypercholesterolaemia		Metabolic / Blood System Di...
E78.0	High cholesterol		Metabolic / Blood System Di...
E78.0	Pure hypercholesterolaemia		Metabolic / Blood System Di...
J84.8	Pneumonitis, cholesterol		Lung / Upper Respiratory Tra...
K82.4	Cholesterolosis, gallbladder	X	Liver / Gall Disorders
K82.4	Cholesterolosis of gallbladder	X	Liver / Gall Disorders
E78.2	Hypercholesterolaemia with endogenous hyperglyceridaemia		Metabolic / Blood System Di...
F78.6	lecithin cholesterol acyltransferase deficiency		Metabolic / Blood System Di...

Filter for Conditions:

Duration: from (DD.MM.YYYY) to (DD.MM.YYYY)

Shortterm Treatment (max 1 month)

Status: Current Illness / Proposed Treatment (P) Associated Illnesses Present (I) Previous Inpatient Treatment (T) Previous Operation (O)

Group by Disease Groups: Build Groups

General | Restrictions

Status: Current

Restrictions: BE

enter filter condition...

Case Date: --- ED19 3.34.2 534 08.05.2007 18:49

File ?



Policy Details | Conditions | Medical Parameters | Results | Report

Policy No.: 123456789 Name: Peter Random Age at Entry: 35 BMI: 26

All Products

Overview

Product	Reasons	Recommendation	Loading
Compact Comfort	E78.0 High cholesterol; I10.90 Hypertension	LD	76 %
Ambulant Basic	E78.0 High cholesterol; I10.90 Hypertension	LD	64 %
Hospital Plus	E78.0 High cholesterol; I10.90 Hypertension	BE; LD	26 %
Dental Basic		---	---

Product 1: Compact Comfort

Product 2: Ambulant Basic

Recommendation (minimal BE)

Reasons

Risks

Disease Group	BE/BR	Relative Risk	Loading
Hypertension	---	366 %	11 %
Ischaemia	---	359 %	9 %
Cardiac Circulatory Disorders (except Ischaemia)	---	331 %	1 %
Arteries / Brain Vessels Disorders	---	516 %	2 %
Urinary System Disorders	---	415 %	11 %
Spinal Column / Joints Disorders	---	84 %	13 %
Other Scopes	---	---	17 %

Product 3: Hospital Plus

Product 4: Dental Basic

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Next >>

Case Date: 08.05.2007 ED19 3.34.2 534

08.05.2007

18:57



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